The Benefits and Drawbacks of Using Kettlebells in a Training Program

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Outline

• Educational Perspective and Scope of Presentation
• Muscle Activation – Landmark Study
• Kettlebells and Low Back Pain
• Kettlebells and Calories
• Kettlebells and Strength/Power Production
• Questions?
Questions That Will Be Answered

• What muscles are activated with kettlebell swings?
• What are the low back joint loads encountered during a 1-arm kettlebell swing?
• Can kettlebell swings improve low back pain?
• How many calories are burned during a kettlebell workout?
• Can kettlebell swings improve muscular strength and power production (vertical jump performance)?
Scope of Presentation

• What I can provide you (and what I cannot!)

• My goal is to challenge you

• You will be an expert on the scientific research of kettlebells
Scope of Presentation

• 12 scientific articles published on kettlebells
  – 2 Reviews
  – 2 Muscle Activation (1 on back loads)
  – 5 Muscular Strength & Power Production (vertical jump)
  – 2 Caloric Expenditure
  – 1 Musculoskeletal Health (low back pain)
Scope of Presentation

• All of the research articles that will be summarized are based on the fundamental movement of the kettlebell exercise:
  ➢ 2-handed swing
  ➢ 1-handed swing
Important Research Application Note

Sedentary
- Complete Sedentary
- Mostly Sedentary

Active
- Recreationally Active
- Competitive Training
- Elite In Training
What Muscles are Activated with Kettlebell Swings?
What Muscles are Activated with Kettlebell Swings?

Kettlebell swing targets semitendinosus and supine leg curl targets biceps femoris: an EMG study with rehabilitation implications.

Zebis, MK, et al. 
What Muscles are Activated with Kettlebell Swings?

• Objective: To investigate the medial (semitendinosus) and lateral (BF) hamstring muscle activation during the supine leg curl and kettlebell swing.
What Muscles are Activated with Kettlebell Swings?

• Who was in the study?
  – 16 female elite handball and soccer players

• What was measured?
  – EMG activity of the lateral (biceps femoris) and medial (semitendinosus) hamstring muscle

• Results?
  – Kettlebell swing activated the ST ~20% more than the BF
  – Supine leg curl activated the BF ~20% more than the ST
Application

• The semitendinosus has the potential to prevent excessive dynamic valgus and external rotation of the knee joint during sports.

• Thus, specific training targeting the medial hamstring muscle seems important to avoid knee injuries.
What Muscles are Activated and to what Extent During a One-arm Kettlebell Swing?

What are the Low-back Joint Loads Encountered During a 1-arm Kettlebell Swing?
What Muscles are Activated During a 1-Arm Kettlebell Swing?

• Title: Kettlebell Swing, Snatch, and Bottoms-Up Carry: Back and Hip Muscle Activation, Motion, and Low Back Loads

• Authors: McGill SM and Marshall LW

• Citation: Journal of Strength & Conditioning Research 26(1): 16-127, 2012
What Muscles are Activated and what During a 1-Arm Kettlebell Swing?

• Purpose of Study:
  – Among others, the kettlebell swing was analyzed to determine:
    • Peak muscle activation (as a % MVC)
    • Average shear load of L4 on L5
    • Compressive spine loads at L4/L5
What Muscles are Activated During a 1-Arm Kettlebell Swing?

• Who was in the study?
  – 7 healthy males (~26 years) without back pain.
  – Most had kettlebell experience.

• What did they do?
  – All swings were conducted with a 16-kg kettlebell (right hand)
  – Muscle activation was obtained via EMG
    • Reported as a percent of maximal voluntary contraction (MVC)
  – Spine loading involved the use of 4-stage modeling process
    • Shear load of L4 on L5 and compressive spine loads at L4/L5
Kettlebell Swings – Muscle Activation

• The gluteal muscles experienced the greatest activation level:
  – Gluteus Maximus = 76% MVC
  – Gluteus Medius = 70% MVC
<table>
<thead>
<tr>
<th>Swing</th>
<th>Average peak muscle activation (%MVC)</th>
<th>SD</th>
<th>Percentage of peak movement (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD</td>
<td>17.3</td>
<td>10.5</td>
<td>17</td>
</tr>
<tr>
<td>RUSS</td>
<td>44.1</td>
<td>10.2</td>
<td>33</td>
</tr>
<tr>
<td>RLES</td>
<td>45.7</td>
<td>14.2</td>
<td>33</td>
</tr>
<tr>
<td>RGMAX</td>
<td>76.1</td>
<td>36.6</td>
<td>57</td>
</tr>
<tr>
<td>RBF</td>
<td>32.6</td>
<td>24.1</td>
<td>52</td>
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<tr>
<td>LLD</td>
<td>56.2</td>
<td>29.2</td>
<td>30</td>
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<tr>
<td>LUES</td>
<td>55.4</td>
<td>10.9</td>
<td>26</td>
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<tr>
<td>LLKES</td>
<td>52.0</td>
<td>11.7</td>
<td>28</td>
</tr>
<tr>
<td>RRA</td>
<td>6.9</td>
<td>6.5</td>
<td>43</td>
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<tr>
<td>REO</td>
<td>16.5</td>
<td>12.9</td>
<td>53</td>
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<tr>
<td>RIO</td>
<td>42.4</td>
<td>42.6</td>
<td>59</td>
</tr>
<tr>
<td>RGMED</td>
<td>70.1</td>
<td>23.6</td>
<td>56</td>
</tr>
<tr>
<td>RRF</td>
<td>33.5</td>
<td>22.1</td>
<td>52</td>
</tr>
<tr>
<td>LRA</td>
<td>6.7</td>
<td>5.9</td>
<td>49</td>
</tr>
<tr>
<td>LEO</td>
<td>13.7</td>
<td>8.2</td>
<td>55</td>
</tr>
<tr>
<td>LIO</td>
<td>30.2</td>
<td>20.9</td>
<td>55</td>
</tr>
</tbody>
</table>

*RLD = right latissimus dorsi; RUSS = right upper erector spinae; RLES = right lower erector spinae; RGMAX = right gluteus maximus; RBF = right biceps femoris; LLD = left latissimus dorsi; LUES = left upper erector spinae; LLKES = left lower erector spinae; RRA = right rectus abdominis; REO = right external oblique; RIO = right internal oblique; RGMED = right glutes medius; RRF = right rectus femoris; LRA = left rectus abdominis; LEO = left external oblique; LIO = left internal oblique; MVC = maximal voluntary contraction.
Kettlebell Swings – Compression & Load

• Both shear and compressive loads were highest at the beginning of the swing.
  – 461 N of posterior shear of the superior vertebra of L4 on L5
  – 3,195 N of compression
• As a point of reference, a power clean of an Olympic bar from the floor with 27kg of weight on it creates a compressive load of 7,000 N.
# Kettlebell Swings – Compression & Load

**Table 2.** Average compression and shear loads at the L4/L5 spine joint during kettlebell swings.*

<table>
<thead>
<tr>
<th>Point in swing</th>
<th>Compression (N)</th>
<th>Shear (N)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Swing</td>
<td>Swing with kime</td>
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<tr>
<td></td>
<td>Average</td>
<td>SD</td>
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<tr>
<td>Start</td>
<td>3,195</td>
<td>995</td>
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<tr>
<td>Middle</td>
<td>2,328</td>
<td>418</td>
</tr>
<tr>
<td>End</td>
<td>1,903</td>
<td>618</td>
</tr>
</tbody>
</table>

*The shear force represents the superior vertebra shearing posteriorly on the inferior vertebra.
Can Kettlebell Swings Improve Low Back Pain?
Can Kettlebells Improve Low Back Pain?

• Title: Kettlebell Training for Musculoskeletal and Cardiovascular Health: a Randomized Controlled Trial

• Authors: Jay K, Frisch D, Hansen K, et al.

• Citation: Scandinavian Journal of Work, Environment, & Heath. 37(3): 196-203, 2011
Can Kettlebells Improve Low Back Pain?

• Who was in the study?
  – People in an occupation with a high prevalence of musculoskeletal pain symptoms (sedentary office workers)
  – Everyone was asked to rate their pain in their low-back and in their neck/shoulder region

• What did they do?
  – Half did nothing
  – Other half performed kettlebell exercises 3 days/week for 8 weeks (~10-15 minutes)
Figure 2. Illustration of the four progression levels used during the training sessions: (a) the unweighted swing, (b) deadlift with a kettlebell, (c) two-handed swing with a kettlebell, and (d) one-handed swing with a kettlebell.
b) **Low-back pain**

- **Baseline**
- **Follow-up**

<table>
<thead>
<tr>
<th></th>
<th>Training</th>
<th>Control</th>
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</thead>
<tbody>
<tr>
<td>Pain intensity (0-10)</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

* indicates a significant difference.
How many calories are burned during a kettlebell workout?
Kettlebells and Calories

• Title: Oxygen Cost of Kettlebell Swings

• Authors: Farrar RE, Mayhew JL, Koch AJ.

• Citation: Journal of Strength & Conditioning Research 24(4): 1034-1036, 2010
Kettlebells and Calories

• Who was in the study?
  – 10 recreationally active college-aged men (~21 years) with no prior kettlebell experience

• What did they do?
  – Completed a 12-minute exercise bout consisting of performing 2-handed swings using a 16-kg kettlebell
    • Subjects wore a HR monitor and were connected to a metabolic cart to measure oxygen consumption
Kettlebells and Calories

• Subjects completed an average of 265 (± 68) swings during the 12-minute exercise bout.
  – 22 swings per minute
Kettlebells and Calories

• Relative VO₂ averaged 34 ml/kg/min

• This was equivalent to burning **160 calories** in 12 minutes (for a 170 pound male)
  – 13 calories/min

• Although females were not tested in this study, a 130-pound female would have expended about **120 calories**.
  – 10 calories/min
Kettlebells and Calories

• Average oxygen consumption was ~65% VO₂max
  – Exercise intensities at 65% VO₂max have been associated with maximal rates of fat oxidation (burning stored fat for energy).

• However, this particular exercise burned primarily carbohydrates for energy (RER = 1).
Kettlebells and Calories

• The metabolic data reported for the kettlebell exercise were of a similar pattern as circuit training.
  – High RER, moderate VO₂

• This “man-maker” program imparts a greater challenge to the cardiorespiratory system than has been shown with traditional circuit weight training.
  – Average HR was 165 beats/minute or ~87% of maximum heart rate.
  – This relative heart rate was substantially higher than the relative oxygen consumption reported.
What Burns More Calories – Kettlebell Swings or Treadmill Running?
Kettlebell Swings vs. Treadmill Running

• Title: Comparison of Kettlebell Swings and Treadmill Running at Equivalent Rating of Perceived Exertion Values

• Authors: Hulsey CR, Soto DT, Koch AJ, Mayhew JL

• Citation: Journal of Strength & Conditioning Research 26(5): 1203-1207, 2012
Kettlebell Swings vs. Treadmill Running

• Purpose of Study:
  – To compare the metabolic demand of 2-handed kettlebell swings with a treadmill run at an equivalent RPE.

• Who was in the study?
  – 11 males and 2 females (~20 years) who were moderately trained but had no experience with kettlebells.

• What did they do?
  – 10 minute kettlebell swing routine (35s/25s work:rest)
  – 10 minute treadmill run at equivalent RPE
Kettlebell Swings vs. Treadmill Running

**Table 2.** Comparison of cardiovascular and metabolic variables for treadmill running and kettlebell swings (n = 13).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Kettlebell swings</th>
<th>Treadmill running</th>
<th>%Diff*</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE†</td>
<td>15.3 ± 1.2</td>
<td>15.5 ± 1.2</td>
<td>1.1 ± 3.0</td>
</tr>
<tr>
<td>HR (b/min⁻¹)†</td>
<td>180 ± 12</td>
<td>177 ± 11</td>
<td>0.6 ± 9.7</td>
</tr>
<tr>
<td>$\dot{V}O_2$ (ml·kg⁻¹·min⁻¹)‡</td>
<td>34.1 ± 4.7</td>
<td>46.7 ± 7.3§</td>
<td>26.1 ± 9.9</td>
</tr>
<tr>
<td>METS‡</td>
<td>9.7 ± 1.3</td>
<td>13.3 ± 2.1§</td>
<td>26.2 ± 9.9</td>
</tr>
<tr>
<td>RER ($\dot{V}CO_2$/$\dot{V}O_2$max)‡</td>
<td>0.95 ± 0.05</td>
<td>0.94 ± 0.04</td>
<td>-0.6 ± 5.1</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)‡</td>
<td>36.4 ± 3.7</td>
<td>38.2 ± 7.0</td>
<td>2.0 ± 18.7</td>
</tr>
<tr>
<td>Kcal·min⁻¹‡</td>
<td>12.5 ± 2.5</td>
<td>17.1 ± 3.7§</td>
<td>26.7 ± 10.4</td>
</tr>
<tr>
<td>Total kcal‡</td>
<td>375 ± 76</td>
<td>512 ± 111§</td>
<td>37.9 ± 20.4</td>
</tr>
</tbody>
</table>

*%Diff = (Treadmill – Swing)/Treadmill × 100.
†Average of minutes 5, 7, 9, and 10.
‡Average of minutes 4–10.
§Significantly different at p < 0.01.
Can Kettlebell Swings Improve Vertical Jump?
Kettlebell Swings & Vertical Jump

- Title: Effects of Kettlebell Training on Postural Coordination and Jump Performance: A Randomized Controlled Trial
- Authors: Jay K, Jakobsen MD, Sundstrup E, et al.
- Citation: Journal of Strength & Conditioning Research (Published Ahead of Print)
Kettlebell Swings and Vertical Jump

• Who was in the study?
  – 40 people (85% female) in an occupation with a high prevalence of musculoskeletal pain symptoms (sedentary office workers)

• What did they do?
  – Half did nothing
  – Other half performed kettlebell exercises 3 days/week for 8 weeks (20 minutes)
    • 30 seconds of work followed by 30-60 seconds of rest
Figure 2. Illustration of the four progression levels used during the training sessions: (a) the unweighted swing, (b) deadlift with a kettlebell, (c) two-handed swing with a kettlebell, and (d) one-handed swing with a kettlebell.
Did Kettlebell Swings Improve Vertical Jump?

• In sedentary office workers (mostly female), a kettlebell training program did improve vertical jump performance:
  – Kettlebell group improved ~9%
  – Control group improved approximately 4%
Kettlebell Swings & Vertical Jump

• Title: Kettlebell Swing Training Improves Maximal and Explosive Strength

• Authors: Jason Lake and Mike Lauder

• Citation: Journal of Strength & Conditioning Research (Published Ahead of Print)
Kettlebell Swings & Vertical Jump

• Purpose of Study:
  – To determine if kettlebell swing training improves half squat strength and vertical jump
Kettlebell Swings & Vertical Jump

• Who was in the study?
  – 12 active men with at least 3 months of RT experience

• What did they do?
  – 2 times per week for 6 weeks:
    • ½ performed 12 rounds of KB swings (30s/30s work:rest) with a 12 or 16 kg kettlebell
    • ½ performed jump squat exercise (~3 sets of 3 jump squats) with a load that maximized peak power
Kettlebell Swings & Explosive Strength - Results

• No Difference Between the Groups for ½ Squat Strength
  – Kettlebell group improved ~12%
  – Weightlifting group improved ~8%

• No Difference Between the Groups for Vertical Jump
  – Kettlebell group improved ~15%
  – Weightlifting group improved ~24%
Important Research Application Note

Sedentary

Complete Sedentary
Mostly Sedentary

Active

Recreationally Active
Competitive Training
Elite In Training
Can Kettlebell Swings Improve Muscular Strength and Power?
Weightlifting vs. Kettlebells

• Title: Effects of Weightlifting vs. Kettlebell Training on VJ, Strength, & Body Composition

• Authors: Otto WH, Coburn JW, Brown LE, Spiering BA

• Citation: Journal of Strength & Conditioning Research 26(5): 1199-1202, 2012
Weightlifting vs. Kettlebells

• Purpose of Study:
  – To compare the effects of 6 weeks of weightlifting and traditional heavy resistance training vs. kettlebell training on strength and power.

• Who was in the study?
  – 30 healthy men (19-26 years) with ≥ 1 year of RT experience

• What did they do?
  – Each subject trained 2x/week for 6 weeks.
  – Vertical jump, 1RM Power Clean & Squat measured pre/post
# The Programs

## Kettlebell Training (16-kg kettlebell)

<table>
<thead>
<tr>
<th></th>
<th>Weeks 1-3</th>
<th>Weeks 4-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kettlebell Swings</td>
<td>3 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
<tr>
<td>Accelerated Swings</td>
<td>4 sets of 6 reps</td>
<td>6 sets of 4 reps</td>
</tr>
<tr>
<td>Goblet Squats</td>
<td>4 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
</tbody>
</table>

## Weightlifting Training (80% 1RM)

<table>
<thead>
<tr>
<th></th>
<th>Weeks 1-3</th>
<th>Weeks 4-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pulls</td>
<td>3 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
<tr>
<td>Power Cleans</td>
<td>4 sets of 4 reps</td>
<td>6 sets of 4 reps</td>
</tr>
<tr>
<td>Back Squats</td>
<td>4 sets of 6 reps</td>
<td>4 sets of 6 reps</td>
</tr>
</tbody>
</table>
Weightlifting vs. Kettlebells - Results

- No Difference Between the Groups for Vertical Jump
  - Kettlebell group improved ~1%
  - Weightlifting group improved ~4%

- No Difference Between the Groups for 1RM Power Clean
  - Kettlebell group improved ~4%
  - Weightlifting group improved ~9%

- Weightlifting Group was Significantly Better in 1RM Squat
  - Kettlebell group improved ~4.5%
  - Weightlifting group improved ~13.5%
Force & Power Production of 2-Hand Kettlebell Swings

• Title: Mechanical Demands of Kettlebell Swing Exercise

• Authors: Lake JP and Lauder MA

• Citation: Journal of Strength & Conditioning Research 26(12): 3209-3216, 2012
Force & Power Production of 2-Hand Kettlebell Swings

- **Who was in the study?**
  - 16 males (~24 years) with ≥ 6 months of kettlebell, back squat, and jump squat exercise experience

- **What did they do?**
  - 2 sets of 10 maximal effort swings with 16, 24, & 32 kg kettlebells
  - 2 back squats with 20, 40, 60, & 80% 1RM
  - 2 jump squats with 0, 20, 40, & 60% 1RM
    - Subjects were instructed to move the load of interest as quickly as possible using correct technique
Force & Power Production of 2-Hand Kettlebell Swings

• What was measured:
  – Peak Force (absolute and relative to bodyweight)
  – Peak Power (absolute and relative to bodyweight)
## Results – Relative to Body Mass

<table>
<thead>
<tr>
<th></th>
<th>Peak Force (N/kg)</th>
<th>Peak Power (W/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kettlebell</td>
<td>21.5 (32 kg)</td>
<td>34.9 (32 kg)</td>
</tr>
<tr>
<td>Back Squat</td>
<td>28.4 (at 80% 1RM)</td>
<td>25.5 (at 60% 1RM)</td>
</tr>
<tr>
<td>Jump Squat</td>
<td>27.1 (at 40% 1RM)</td>
<td>41.3 (at 0% 1RM)</td>
</tr>
</tbody>
</table>

- Back squat and jump squat produced significantly more peak force than the kettlebell swing.
- Of the three exercises, peak force was maximized during back squat exercise with 80% 1RM.
- Of the three exercises, peak power was maximized during the jump squat with no added resistance.
Kettlebell Training, Strength & Power

- **Title:** Transference of Kettlebell Training to Strength, Power, and Endurance
- **Authors:** Manocchia, et al.
- **Citation:** Journal of Strength & Conditioning Research (Published Ahead of Print)
Kettlebell Training, Strength & Power

• Purpose of Study:
  – To determine if kettlebell training transfers strength and power to powerlifting exercises

• Who was in the study?
  – 37 males and females (18-72 years) who were resistance training for the previous 6 months

• What was measured?
  – 3RM Bench Press
  – 3RM Clean and Jerk
  – Maximal Vertical Jump
Kettlebell Training, Strength & Power

• What did they do?
  – Kettlebell training group performed kettlebell training 2 days per week for 10 weeks
  – Control group did not perform any kettlebell exercises (continued daily activities and nutritional habits)
<table>
<thead>
<tr>
<th>Microcycle</th>
<th>Days</th>
<th>Sets</th>
<th>Reps</th>
<th>Intensity% (RPE)</th>
<th>Exercises</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>1-4</td>
<td>2</td>
<td>15-20</td>
<td>60-65% (6-6.5/10)</td>
<td>1. Dynamic ROM Warm up (Med Ball) / Planks</td>
<td>• Swing cadence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Bilateral Swing</td>
<td>• Demonstrate each exercise</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>3. Unilateral Swing</td>
<td>• Utilization of momentum</td>
</tr>
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<td></td>
<td>4. High Pull</td>
<td>• Plyometric coordination (decelerate to accelerate)</td>
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<td>5. Push Press Bilateral</td>
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<td>6. Squat and Press Bilateral</td>
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<td>7. Side Squat and Tranfer</td>
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<td>8. Iso Push-up and Uni Hip Ext</td>
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<td>9. Push-up</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Microcycle</th>
<th>Days</th>
<th>Sets</th>
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<th>Intensity% (RPE)</th>
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<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>17-20</td>
<td>2-3</td>
<td>8-4</td>
<td>85-95% (8.5-9.5/10)</td>
<td>1. Dynamic Warm Up</td>
<td>• Putting it all together</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. DBL Swings (1KB)</td>
<td>• Complex movements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Clean and Press (2KB)</td>
<td>• Unilateral and bilateral</td>
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<td></td>
<td></td>
<td></td>
<td>4. Uni Switch (1KB)</td>
<td>control of momentum</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>5. Wood Chopper (1KB)</td>
<td>• Rotational movements with speed and efficiency</td>
</tr>
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<td></td>
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<td>6. DBL Ch Press (2KB)</td>
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<td>7. Turkish Get up</td>
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Kettlebell Training, Strength & Power

No improvement in vertical jump
What are the Benefits and Drawbacks of using Kettlebells in a Training Program?
Benefits and Drawbacks – New (i.e., sedentary) Client

• Benefits:
  – Improve lower back pain
  – Improve vertical jump (power production)
  – Improve lower body strength

• Drawbacks:
  – If the primary goal is to burn calories, the inclusion of kettlebells is not the best mode of activity
  – Technique driven skill and must be able to squat correctly
Benefits and Drawbacks – Advanced Client/Athlete

• Benefits:
  – Activation of the semitendinosus
    • Potential to prevent excessive dynamic valgus and reduce possible knee injuries

• Drawbacks:
  – Not as good of a tool as traditional resistance training for the following:
    • Muscular strength
    • Power Clean
    • Vertical Jump
    • Peak power production
Questions?